ARTEMISIA ARBUSCULA, A. LONGILOBA, AND *A. NOVA* HABITAT TYPES IN NORTHERN NEVADA

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Abstract.— *Artemisia arbuscula*, *A. longiloba*, and *A. nova* are dwarf sagebrush species that occur extensively throughout the shrub steppe of northern Nevada. These species are similar ecologically in that they occupy habitats strongly influenced by edaphic factors. Nine major habitat types on which these shrubs are dominant are recognized in this region. The *A. arbuscula* habitat types are most prevalent in extreme northern Nevada. Southward, they generally become restricted to altitudes above the *Pinus-Juniperus* woodland zone. A single *A. longiloba* habitat type is described, occurring in northeastern Nevada. The *A. nova* habitat types are most prevalent in north central and east central Nevada. Four features appear consistently among soils of these habitat types: (1) shallowness, (2) high profile gravel volume, (3) presence of a clay B horizon close to the soil surface, and (4) presence of large quantities of mineral carbonates throughout profiles of most *A. nova* habitat types.

Artemisia arbuscula, *A. longiloba*, and *A. nova* are dwarf sagebrush species which dominate approximately one-half of the sagebrush vegetation in Nevada (Beetle, 1960). The most extensive communities of these species in Nevada occur in the northern portions of the state and form very distinct and important components of the shrub steppe of this region. Excessive livestock grazing in past years has greatly altered the herbaceous composition of the vegetation of many of these communities. Virtually no synecological studies of undisturbed *A. arbuscula*, *A. longiloba*, and *A. nova* vegetation have been undertaken in Nevada (Passey and Hugie, 1962). Such information would be useful in ascertaining the biotic potential and limitations of the habitats occupied by these shrubs and would greatly aid in the management and manipulation of these communities for grazing and watershed purposes. The purpose of this study was to delimit the characteristics of the major *A. arbuscula*, *A. longiloba*, and *A. nova* habitat types in the shrub steppe of northern Nevada.

Study Area

The study encompassed areas throughout northern Nevada where these species of sagebrush were abundant and where undisturbed vegetation would likely be found. The region referred to as northern Nevada is that portion of the state generally north of the 39th parallel. The physiography of much of this region consists of numerous, short mountain ranges and intermontane basins with internal drainage. Extreme northern Nevada consists of an upwarped plateau of hilly and mountainous terrain with major drainage into the Snake River to the north in Oregon and Idaho. Soils of this region belong predominantly to the Aridisol, Entisol, Mollisol, and Vertisol orders. The climate is arid. The mean annual temperature is 8.9 C, with the coldest temperatures occurring in December through February

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(mean=2.2 C) and the warmest in July and August (mean=20.8 C). The mean total annual precipitation is 239.2 mm. The long-range normals (in mm) for total monthly precipitation are as follows: January 29.2, February 26.4, March 23.9, April 22.9, May 24.6, June 18.0, July 9.9, August 7.6, September 9.9, October 18.8, November 20.6, December 27.4.

The shrub steppe in extreme northern Nevada appears as a uniform, continuous shrub cover occasionally interrupted by *Juniperus* or *Cercocarpus* woodlands. In north central Nevada, shrub steppe communities occupy basins and lower pediment slopes of the mountain ranges. At higher altitudes, the shrub steppe is interrupted by a zone of *Pinus monophylla* and *Juniperus osteosperma* woodlands (Billings, 1951). Above this zone, shrub communities again appear, particularly those dominated by *Artemisia.*

Methods

A preliminary reconnaissance of the vegetation dominated by *Artemisia arbuscula. A. longiloba*, and *A. nova* gave an indication of the community types, distribution, and pattern of occurrence. Lists of the dominant species within each stand were taken during the reconnaissance. These species were then ranked according to their abundance. Nine community types were subjectively delineated by examination of these lists in stand tables. Based on this initial classification, 39 stands representing the various community types were selected for detailed study on the basis of the following criteria: absence of disturbance due to grazing, erosion, and wildfire; absence of a tree overstory; presence of a uniform shrub and grass cover.

Vegetation data were collected from a 15-by-30-m macroplot located within each of the 39 stands. Ten 15-m transects were randomly located perpendicular to the long axis of the macroplot. Frequency data for plant species were collected from 10 3-by-6-dm observation plots placed at 1-m intervals along each transect. Only species rooted within each observation plot were tallied. The same observation plots were used to sample basal area of each species along 4 of the 10 transects. Species not recorded in the observation plots but present within the macroplot were listed. Shrub measurements were collected from 1-by-1-m plots placed contiguous and parallel to the same 4 transects from which basal area data were collected. Crown cover, density, and maximum heights were recorded for each shrub species within each meter-square plot.

Physiographic features recorded at each location were: percentage slope, slope aspect, position of the stand on the slope, elevation, landform on which the stand occurred, and terrain of the general area in which the stand occurred. A profile description of the soil underlying each stand was made and identified to the family level (Soil Survey Staff, 1967). One soil sample from each horizon of each profile was collected for laboratory analysis. Soil reaction was measured on a saturated paste with a glass electrode pH meter. Electrical conductivity of an extract from a saturated paste was determined only on the A1 and B2 horizons of each profile. Calcium carbonate equivalents were determined by gravimetric loss of carbon dioxide upon treatment with 3NHCl for all horizons.

The vegetation data from the 39 stands were summarized in stand tables and mean values for the various characteristics calculated. The vegetation and associated environmental characteristics were interpreted according to the association and habitat type synecological concepts (Daubenmire, 1968). Stands similar in both shrub and herb dominance were considered representative of an association. A habitat type is a unit of land that now supports or is still capable of supporting one plant association. The name of each habitat type consists of the name of the principal shrub and herb of the association which occupies it. Species nomenclature follows that of Ward (1953) and Beetle (1960) for *Artemisia* and Holmgren and Reveal (1966) for other vascular plants.

Description of Habitat Types

Artemisia arbuscula is most abundant throughout extreme northern Nevada. Southward into central Nevada, *A. arbuscula* is found predominantly at higher altitudes above the *Pinus monophylla-Juniperus osteosperma* woodland zone. *A. longiloba* occurs almost entirely within a small area in north central Elko County in northeastern Nevada. Occasional small, insular stands may be found in surrounding counties. *A. nova* is most abundant in the north central and eastern portions of the state. Scattered, insular stands may be found throughout northern and southern Nevada.

The physiognomy of the vegetation is quite similar throughout the entire range of these species in Nevada. The shrubs appear as a low, uniformly distributed population interspersed by perennial, caespitose grasses. Separate shrub and grass layers are not always distinguishable because of the similarity in height of most shrubs and grasses. In most areas, individual stands of these dwarf sagebrush species are contiguous to extensive communities of *A. tridentata*, the predominant sagebrush species in Nevada. Ecotones between contiguous stands often appear abrupt. The low, compact growth form of *A. arbuscula*, *A. longiloba*, and *A. nova* contrast sharply with the taller, robust, and diffusely branched growth form of *A. tridentata*.

Nine major habitat types were recognized on the basis of shrub and grass dominance in this region. The 39 stands studied in detail represent the vegetation of 8 of the habitat types. An additional habitat type is described on the basis of reconnaissance data only. Constancy, basal area, and frequency of major plant species in each association are given in Tables 1 and 3. Shrub characteristics are shown in Tables 2 and 4.

(1) *Artemisia arbuscula-Festuca idahoensis* habitat type

This habitat type is found on slopes and ridgetops of hilly and mountainous terrain throughout much of northern Nevada at alti-

TABLE 1. Mean values for vegetation characteristics[a] of the *Artemisia arbuscula* and *A. longiloba* associations.

Species	*A. arbuscula–Festuca idahoensis* n=5[b]			*A. longiloba–Festuca idahoensis* n=2			*A. arbuscula–Stipa thurberiana* n=4			*A. arbuscula–Agropyron spicatum* n=9			*A. arbuscula–Purshia tridentata–Agropyron spicatum* n=3		
	CN	FR	CV	CN	FR	CV	CN	FR	CV	CN	FR	CV	CN	FR	CV
SHRUBS															
Artemisia arbuscula	100	55	0.8	—	—	—	100	45	1.0	100	64	1.4	100	51	1.7
Artemisia longiloba	—	—	—	100	58	1.4	—	—	—	—	—	—	—	—	—
Chrysothamnus viscidiflorus	100	11	0.1	50	5	T	100	10	0.1	89	14	0.1	100	3	T
Eriogonum heracleoides	60	9	T	50	4	0.1	—	—	—	11	—	—	67	4	T
Eriogonum microthecum	60	3	T	—	—	—	100	5	T	56	11	T	67	17	T
Leptodactylon pungens	40	1	T	50	11	T	75	5	T	40	4	T	—	—	—
Tetradymia canescens	—	—	—	—	—	—	—	—	—	33	T	—	100	1	T
Symphoricarpos longiflorus	—	—	—	—	—	—	—	—	—	22	T	T	67	4	T
Artemisia tridentata	—	—	—	—	—	—	—	—	—	11	T	T	100	2	T
Purshia tridentata	—	—	—	—	—	—	—	—	—	11	—	—	100	31	1.0
GRASSES															
Festuca idahoensis	100	68	2.1	100	80	2.7	50	8	0.1	—	—	—	—	—	—
Poa sandbergii	100	76	1.2	100	74	1.2	100	72	0.5	100	84	1.4	100	23	0.1
Agropyron spicatum	100	33	0.4	100	35	0.7	100	2	T	100	68	1.6	100	71	0.6
Sitanion hystrix	100	11	T	100	27	0.3	100	37	0.3	89	11	T	100	2	T
Koelaria cristata	40	2	T	—	—	—	75	4	T	—	—	—	—	—	—
Stipa thurberiana	40	4	T	—	—	—	100	59	1.1	33	6	T	—	—	—
Bromus tectorum	20	T	—	—	—	—	75	14	T	67	4	T	67	17	T
Poa nevadensis	—	—	—	—	—	—	—	—	—	—	—	—	67	9	T
Stipa lettermani	—	—	—	—	—	—	—	—	—	—	—	—	67	2	T
FORBS															
Collinsia parviflora	100	61	T	100	11	T	100	84	0.1	67	41	T	100	66	T
Antennaria dimorpha	100	3	T	—	—	—	100	7	T	44	2	T	—	—	—
Erigeron bloomeri	100	4	T	—	—	—	100	14	T	—	—	—	—	—	—
Agoseris glauca	80	26	T	100	29	T	100	10	T	56	7	T	—	—	—
Crepis accuminata	80	7	T	—	—	—	50	2	T	56	1	T	100	3	T
Balsamorhiza sagittata	80	—	—	—	—	—	25	1	T	22	—	—	100	8	T

TABLE 1 (Continued)

Allium acuminatum	80	19	T	50	5	T	10	5	T	—	—	—	—	—	—
Phlox longifolia	80	35	T	100	50	T	100	34	T	89	48	T	100	45	T
Arabis holboellii	80	9	T	50	11	T	75	T	—	89	10	T	100	7	T
Astragalus purshii	80	5	T	—	—	—	100	2	T	67	3	T	100	3	T
Senecio integerrimus	60	20	T	100	30	T	25	1	—	11	T	T	33	6	T
Polygonum spergulariaeforme	60	11	T	100	46	T	—	—	—	33	2	T	100	19	T
Chaenactis douglasii	60	1	T	—	—	—	25	—	—	—	—	—	—	—	—
Gayophytum ramosissimum	60	18	T	—	—	—	—	—	—	56	11	T	33	T	T
Mertensia oblongifolia	60	9	T	—	—	—	—	—	—	—	—	—	—	—	—
Microsteris gracilis	60	23	T	—	—	—	75	24	T	22	15	T	—	—	—
Trifolium gymnocarpon	60	10	T	50	5	T	50	3	T	—	—	—	—	—	—
Cryptantha spp.	40	T	T	100	10	T	25	4	T	67	12	T	67	2	T
Aster scopulorum	40	10	T	—	—	—	100	21	0.4	67	5	T	67	6	0.1
Astragalus miser	40	7	T	—	—	—	100	5	T	22	5	T	—	—	—
Cordylanthus ramosus	40	9	T	100	14	T	—	—	—	11	3	T	—	—	—
Delphinium andersoni	40	4	T	—	—	—	100	5	T	11	T	T	67	1	T
Haplopappus carthamoides	40	7	T	100	5	—	—	—	—	—	—	—	—	—	—
Lomatium dissectum	40	11	T	—	—	—	100	13	T	—	—	—	—	—	—
Phlox hoodii	40	5	0.1	—	—	—	100	10	0.2	—	—	—	—	—	—
Descurainia pinnata	20	T	—	50	2	T	100	21	T	11	6	T	33	3	T
Eriastrum sparsiflorum	20	11	T	—	—	—	75	28	T	22	7	T	—	—	—
Eriogonum ovalifolium	20	1	T	50	9	0.2	75	4	T	—	—	—	—	—	—
Castilleja chromosa	—	—	—	50	8	T	—	—	—	56	4	T	100	1	T
Calochortus nuttallii	—	—	—	—	—	—	—	—	—	44	T	T	100	3	T
Chenopodium leptophyllum	—	—	—	—	—	—	—	—	—	33	T	T	100	3	T
Crepis modocensis	—	—	—	—	—	—	—	—	—	33	T	T	67	11	T
Haplopappus acaulis	—	—	—	—	—	—	—	—	—	33	6	0.1	100	7	0.2
Penstemon watsonii	—	—	—	—	—	—	—	—	—	22	1	T	67	14	T
Senecio millelobatus	—	—	—	—	—	—	—	—	—	11	T	T	66	T	T
Erigeron eatonii	—	—	—	—	—	—	—	—	—	—	—	—	67	7	T

[a]Only species which attain a constancy of 60 percent or greater in one association are shown;
CN = constancy (percentage of occurrence of a species in stands of a given association);
FR = percentage of 100 3-by-6-dm plots in which a given species occurs;
CV = basal area (percentage basal coverage within a 3-by-6-dm plot);
T = trace (frequency less than 1 percent; basal area less than 0.1 percent).
[b]n = number of stands studied in detail.

Table 2. Mean values for shrub characteristics[a] of the *Artemisia arbuscula* and *A. longiloba* associations.

	A. arbuscula–Festuca idahoensis			*A. longiloba–Festuca idahoensis*			*A. arbuscula–Stipa thurberiana*			*A. arbuscula–Agropyron spicatum*			*A. arbuscula–Purshia tridentata–Agropyron spicatum*		
	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv
Artemisia arbuscula	219	18	12	—	—	—	126	19	12	266	11	12	168	17	16
Artemisia longiloba	—	—	—	200	24	19	—	—	—	—	—	—	—	—	—
Chrysothamnus viscidiflorus	28	17	1	5	18	T	29	19	T	35	12	1	6	32	T
Eriogonum microthecum	5	11	T	1	15	T	6	16	T	28	13	T	30	22	1
Artemisia tridentata	T	46	T	T	60	T	T	20	T	T	26	T	4	33	T
Leptodactylon pungens	2	20	T	16	21	T	18	17	T	7	16	T	—	—	—
Tetradymia canescens	3	27	T	—	—	—	—	—	—	T	15	T	2	31	1
Eriogonum heracleoides	16	12	T	—	—	—	—	—	—	—	—	—	—	—	—
Purshia tridentata	—	—	—	—	—	—	—	—	—	T	13	T	56	47	19
Symphoricarpos longiflorus	—	—	—	—	—	—	—	—	—	—	—	—	5	32	2

[a]No = density (number of plants per 60 m^2); Ht = maximum height in cm; Cv = crown cover of a m^2 plot; T = trace (crown cover value less than 1 percent; density less than 1 plant per 60 m^2).

TABLE 3. Mean values for vegetation characteristics[a] of three *Artemisia nova* associations.

Species	*A. nova–Agropyron spicatum* n=6[b]			*A. nova–Agropyron inerme* n=5			*A. nova–Stipa comata* n=5		
	Cn	Fr	Cv	Cn	Fr	Cv	Cn	Fr	Cv
TREES									
Juniperus osteosperma	66	T	—	—	—	—	20	—	—
Pinus monophylla	33	T	—	—	—	—	60	T	—
SHRUBS									
Artemisia nova	100	56	1.2	100	57	1.2	100	56	1.5
Chrysothamnus viscidiflorus	83	8	T	100	4	T	100	5	0.1
Eurotia lanata	17	2	T	20	T	—	80	7	T
Ephreda viridis	—	—	—	—	—	—	60	1	T
GRASSES									
Agropyron spicatum	100	79	1.4	—	—	—	—	—	—
Poa sandbergii	100	37	0.3	100	42	0.2	100	5	T
Sitanion hystrix	17	4	T	80	6	T	100	6	T
Agropyron inerme	—	—	—	100	58	1.4	—	—	—
Stipa comata	—	—	—	—	—	—	100	50	0.5
FORBS									
Calochortus nuttallii	100	6	T	20	T	T	100	4	T
Phlox longifolia	100	36	T	60	6	T	80	10	T
Arabis holboellii	83	8	T	100	9	T	80	2	T
Haplopappus acaulis	83	17	0.4	60	1	T	—	—	—
Astragalus purshii	67	3	T	60	1	—	100	3	T
Cryptantha humilis	67	12	T	—	—	—	—	—	—

TABLE 3 (Continued).

Streptanthus cordatus	67	T	T	—	—	—	20	T	T
Agoseris glauca	50	3	T	60	4	T	—	—	—
Astragalus beckwithii	50	T	T	80	4	T	—	—	—
Delphinium andersoni	33	2	T	60	2	T	—	—	—
Eriogonum ovalifolium	33	1	T	40	T	—	60	1	T
Gilia clokeyi	33	23	T	40	6	T	100	9	T
Lomatium macdougali	33	T	T	100	11	T	—	—	—
Cryptantha spp.	17	T	T	60	1	T	60	2	T
Linum lewisii	17	T	T	—	—	—	60	T	T
Erigeron pumilis	—	—	—	100	1	T	80	2	T
Descurainia pinnata	—	—	—	60	3	T	60	2	T

[a]Only species which attain a constancy of 60 percent or greater in one association are shown;
Cn = constancy (percentage of occurrence of a species in stands of a given association);
Fr = percentage of 100 3-by-6-dm plots in which a given species occurs;
Cv = basal area (percentage basal coverage within a 3-by-6-dm plot);
T = trace (frequency less than 1 percent; basal area less than 0.1 percent)
[b]n = number of stands studied in detail.

TABLE 4. Mean values for shrub characteristics[a] of three *Artemisia nova* associations.

	A. nova–Agropyron spicatum			*A. nova–Agropyron inerme*			*A. nova–Stipa*		
	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv
Artemisia nova	181	23	13	133	14	11	216	15	12
Chrysothamnus viscidiflorus	17	20	1	7	15	T	18	13	T
Eurotia lanata	7	6	T	T	9	T	15	14	T
Ephreda viridis	T	30	T	T	11	T	1	49	T
Eriogonum microthecum	4	12	T	—	—	—	—	—	—
Tetradymia canescens	2	22	T	—	—	—	—	—	—
Leptodactylon pungens	2	27	T	—	—	—	—	—	—
Grayia spinosa	—	—	—	T	19	T	—	—	—
Atriplex confertifolia	—	—	—	2	19	T	2	16	T

tudes ranging from 1900 to 2000 m. *Artemisia arbuscula* is the dominant shrub of the association. *Festuca idahoensis* is the dominant perennial herb, with *Poa sandbergii* and *Agropyron spicatum* the principal subdominants. Low scattered bushes of *Chrysothamnus viscidiflorus* occur in all stands. *Bromus tectorum*, the only annual grass, occurs in very minute amounts but becomes abundant in most seral stands. Forbs in all *Artemisia arbuscula* associations are very low in basal area but often attain relatively high frequencies. Soils supporting stands studied in detail were divided among the subgroups Typic Haploxerolls, Typic Argixerolls, Typic Durixerolls, and Xerollic Camborthids. The association is similar to those described by Eckert (1957), Tueller (1962), Culver (1964), Hall (1967), and Dealy (1971) in central and eastern Oregon.

(2) *Artemisia longiloba-Festuca idahoensis* habitat type

In north central Elko County in northeastern Nevada, stands of *Artemisia longiloba* may be found on slopes of gently rolling to hilly terrain at altitudes ranging from 1900 to 2100 m. Only two stands were found that were not extensively altered by grazing. Except for the substitution of *Artemisia longiloba* for *Artemisia arbuscula*, the vegetation closely resembles that of the *Artemisia abruscula-Festuca idahoensis* association in both floristics and abundance of herbaceous species. Soils of the two stands belong to the subgroups Xerollic Camborthids and Mollic Paleargids. Tisdale, Hironaka, and Fosberg (1965) described a pristine *Artemisia longiloba-Festuca idahoensis-Stipa thurberiana* community in southern Idaho. The abundance of *S. thurberiana* was the only major difference between the community in Idaho and the two stands in Nevada. Hugie, Passey, and Williams (1964) described an *Artemisia longiloba* community in the Snake River Plain, Idaho, in which *F. idahoensis*, *Agropyron spicatum*, and *Poa sandbergii* were the principal grasses. Robertson, Nielsen, and Bare (1966) report that *Agropyron spicatum* is the predominant grass associated with *Artemisia longiloba* on range site in Colorado.

(3) *Artemisia arbuscula-Stipa thurberiana* habitat type

The *Artemisia arbuscula-Stipa thurberiana* habitat type occurs on gently rolling to hilly terrain primarily in northwestern Nevada at altitudes varying around 1800 m. Stands are distinguished by the dominance of the perennial grass *Stipa thurberiana*. Subdominant grasses include *Poa sandbergii* and *Sitanion hystrix*. *Festuca idahoensis* is low in constancy. Mat-forming forbs are a conspicuous component of the vegetation, the most prevalent species being *Eriogonum ovalifolium*, *Phlox hoodii*, *Aster scopulorum*, and *Astragalus purshii*. Soils underlying stands studied in detail belong to the subgroups Mollic Paleic Durargids, Mollic Paleargids, Mollic Haplargids, and Typic Durixerolls.

(4) *Artemisia arbuscula-Agropyron spicatum* habitat type

The *Artemisia arbuscula-Agropyron spicatum* habitat type occurs on slopes and ridgetops of hilly and mountainous terrain in northeastern and east central Nevada (Figure 1). Altitudes of stands range from 1900 to 2700 m. The association is characterized by the abundance of *Agropyron spicatum*. *Festuca idahoensis* is usually absent but may occur in minute amounts. In some stands, *Poa sand-*

Fig. 1. Stand representative of the *Artemisia arbuscula–Agropyron spicatum* association in northern Nevada. The meter stake is marked in decimeters.

bergii may equal or exceed *Agropyron spicatum* in both basal area and frequency. *Chrysothamnus viscidiflorus* is the only other shrub of high constancy. In east central Nevada, this association was found only above the *Pinus-Juniperus* woodland zone. The growth form of *Artemisia arbuscula* was greatly altered at these higher altitudes, appearing as an almost prostrate shrub with dense, flattened canopies. Scattered bushes of *Artemisia frigida* and *Artemisia nova* may be present in these stands. Soils supporting the stands studied in detail are divided among the subgroups Lithic Argixerolls, Typic Haploxerolls, and Mollic Haplargids. Eckert (1957), Culver (1964), and Hall (1967) described similar associations in central and eastern Oregon.

(5) *Artemisia arbuscula-Purshia tridentata-Agropyron spicatum* habitat type

The *Artemisia arbuscula-Purshia-Agropyron* habitat type was found only on the pediment slopes of Duck Creek Basin in the Schell Creek mountain range northeast of Ely, Nevada (Figure 2). These slopes are dissected, forming many narrow to broadly rounded ridges extending from the mountain range into the basin. Stands occur between 2400 and 2500 m elevation. All soils described belong to the subgroups Typic Argixerolls. Codominance of the shrubs *Artemisia arbuscula* and *Purshia tridentata* characterizes the association. *Pursh-*

Fig. 2. Stand representative of the *Artemisia arbuscula Purshii tridentata-Agropyron spicatum* association in the Duck Creek Basin in east central Nevada.

ia tridentata has a slightly larger crown cover than *Artemisia arbuscula* but considerably lower density (Table 2). Scattered individuals of *Artemisia tridentata*, *Symphoricarpos longiflorus*, *Tetradymia canescens*, and *Chrysothamnus viscidiflorus* occur throughout the vegetation. *Agropyron spicatum* is the dominant perennial herb. Stands of this association occur at the lower edges of the *Pinus monophylla-Juniperus osteosperma* zone within the basin. Dealy (1971) described a *Purshia tridentata-Artemisia arbuscula-Stipa thurberiana* community in south central Oregon which occurred near the lower edge of the *Pinus ponderosa* forests.

(6) *Artemisia nova–Agropyron spicatum* habitat type

The *Artemisia nova–Agropyron spicatum* habitat type occurs throughout north central Nevada, principally on slopes of gently rolling to hilly terrain at altitudes ranging from 2000 to 2300 m (Figure 3). This habitat type may also occur at higher altitudes on certain mountain ranges where soils are derived from calcareous parent materials. Such areas are found in the Snake, Schell Creek, and Egan ranges of east central Nevada. *Artemisia nova* is the principal shrub and *Agropyron spicatum* the principal herb. *Poa sandbergii* occurs in small amounts in most stands but increases in abundance at higher elevations. Other grasses such as *Poa nevadensis*,

Fig. 3. Stand representative of the *Artemisia nova–Agropyron spicatum* association on slopes of the Schell Creek Range in east central Nevada. The meter stake is marked in decimeters.

Bromus tectorum, *Oryzopsis hymenoides*, *Sitanion hystrix*, and *Stipa thurberiana* are present in very limited amounts. *Chrysothamnus viscidiflorus* is the only other shrub of high constancy. Stands of this association and *Artemisia tridentata* communities often constitute the major vegetation directly below and above the *Pinus monophylla–Juniperus osteosperma* woodland zone in east central Nevada. *Artemisia nova* may also occupy openings within the woodlands and form a shrub layer beneath the tree canopies. The soils supporting the stands studied in detail were divided among the subgroups Typic Torriorthents, Pachic Argixerolls, Typic Durixerolls, Pachic Haploxerolls, and Xerollic Paleorthids.

(7) *Artemisia nova–Agropyron inerme* habitat type

This habitat type occurs on foothill slopes of the Pancake mountain range predominantly in Nye County in central Nevada. It ranges in altitude from 1800 to 2100 m. *Agropyron inerme* is the dominant herb. The tall, robust, caespitose growth form of this grass is the most conspicuous feature of the physiognomy. *Poa sandbergii* and *Sitanion hystrix* are the only other grasses with high constancy among the stands. Stands of the *Artemisia nove–Agropyron inerme* association are commonly associated with extensive communities of *Atriplex confertifolia* and *Grayia spinosa*. Influence of the *Atriplex* and *Grayia* vegetation on these stands is evident in the presence of shrubs such as *Atriplex confertifolia*, *Eurotia lanata*, *Ephedra viridis*, and *Grayia spinosa*, which are characteristic of the *Atriplex* and *Grayia* vegetation. The soils described belong to the Aridisol subgroups Mollic Paleargids, Mollic Haplargids, and Lithic Mollic Haplargids.

(8) *Artemisia nova–Stipa comata* habitat type

The *Artemisia nova–Stipa* habitat type is found in White Pine County on pediment slopes of hilly terrain. The altitudinal range is 2000 to 2200 m. The association is characterized by the abundance of *Stipa comata*. *Poa sandbergii* and *Sitanion hystrix* are highly constant grasses but are low in frequency and basal area. *Bromus tectorum* and *Hilaria jamesii* may be present in very small amounts. *A. nova* has a high density in comparison to other *A. nova* associations (Table 2). Scattered individuals of *Chrysothamnus viscidiflorus* and *Eurotia lanata* are generally present. Soils underlying these stands belong to the subgroups Typic Torriorthents and Xerollic Paleorthids.

(9) *Artemisia nova–Oryzopsis hymenoides* habitat type

The *Artemisia nova–Oryzopsis* habitat type is described only from reconnaissance data. The vegetation of this habitat type has been severely grazed by livestock in the past. Because of the nature of the terrain, the vegetation is easily accessible and conducive to fall and winter grazing by livestock. No stands were found that had not been affected by grazing to various degrees. However, the species composition of the vegetation is quite constant over large areas even though the herbage is often reduced to very small quantities by livestock.

The habitat type occurs extensively on undulating and gently rolling pediment slopes in the intermontane basins in central and east central Nevada (Figure 4). These slopes are generally less than 5 percent in steepness. Areas of the *Artemisia nova–Oryzopsis* habitat type generally occur over an altitudinal range of 1800-2300 m. Soils are predominantly of the Aridisol and Entisol orders.

Artemisia nova is the dominant species of the vegetation. *Chrysothamnus viscidiflorus* and *Eurotia lanata* are the only shrubs commonly occurring with *Artemisia nova.* The following additional shrubs may occur and are listed in order of decreasing presence: *Ephredra viridis*, *Atriplex confertifolia*, *Eriogonum microthecum*, *Artemisia tridentata*, *Leptodactylon pungens* and *Tetradymia canescens.* The herb layer is very sparse, composed principally of the caespitose grass *O. hymenoides.* Other grasses that may be occasionally found are *Poa sandbergii*, *Sitanion hystrix*, *Stipa comata*, and *Hilaria jamesii.* Forb species are generally scarce throughout the vegetation. The most abundant, in order of decreasing presence, are *Phlox hoodii*, *Eriogonum ovalifolium*, *Haplopappus acaulis*, *Caulanthus crassicaulis*, *Erigeron pumilis*, *Phlox longifolia*, *Sphaeralcea*

Fig. 4. Stand representative of the *Artemisia nova–Oryzopsis hymenoides* association in central Nevada.

grossulariaefolia, and *Astragalus calycocus*. Stands of the *Artemisia nova–Oryzopsis* association are commonly contiguous with stands of *Atriplex*, *Eurotia lanata*, and *Grayia spinosa*.

Soils

Considerable variation in morphology was encountered among the soils of the *Artemisia arbuscula*, *Artemisia longiloba* and *Artemisia nova* habitat types. Of the 39 soils described, 25 different families were identified. This was expected, since many of the soils are distributed over a wide geographical area and occur in a variety of topographic positions. The more prominent features of the collective soils are described.

The sola thickness of soils of the *Artemisia arbuscula* and *Artemisia longiloba* habitat types varied from 23 to 87 cm, with an average of 55 cm. Sixty-five percent of these soils have dense clay horizons (B2t). The upper boundaries of these horizons varied from 7 to 36 cm below the soil surface, with an average of 19 cm. These prominent clay horizons did not form a root-restricting layer, since roots were abundant throughout their depth. Sixty-five percent of the soils have sola with high gravel volumes ranging from 20 to 62 percent. The majority of these soils belong to the *Artemisia arbuscula–Agropyron* and *Artemisia arbuscula–Purshia–Agropyron* habitat types. Those soils lacking dense clay horizons have sola with high gravel volumes. Root-restricting layers (duripans or bedrock) were found in only 21 percent of the soils, occurring at depths of 23-87 cm. The remaining soils were generally underlain by gravelly loam strata. The occurrence of these layers was not restricted to soils of any particular habitat type. Sola of the *Artemisia arbuscula* and *Artemisia longiloba* soils were not calcareous nor alkaline. Soil reaction of the A1 and B2 horizons varied from pH 5.5 to 7.4, with electrical conductivities ranging from 0.1 to 1.0 mmhos per cm.

The sola thickness of soils of the *Artemisia nova* habitat types varied from 7 to 89 cm, with an average of only 26 percent of the *Artemisia nova* soils described having dense clay horizons. The upper boundaries of these horizons ranged from 7 to 15 cm below the soil surface. Eighty-one percent of the *Artemisia nova* soils have high volumes of gravel in their sola, varying from 26 to 52 percent. Root-restricting layers (duripans, petrocalcic horizons, or bedrock) were found in 50 percent of the soils at depths of 29-68 cm and did not occur predominantly in any one habitat type. The remaining soils were generally underlain by gravelly and sandy loam strata. The majority of the soils of the *Artemisia nova* habitat types are calcareous throughout their sola. Percentage $CaCO_3$ equivalents of the A1 and B2 horizons varied from 9 to 36 percent. Soil reaction of these horizons ranged from pH 6.6 to 8.5, with electrical conductivities varying from 0.2 to 0.7 mmhos per cm. However, sola of soils of the *Artemisia nova–Agropyron inerme* habitat type are generally free of detectable mineral carbonates. Carbonates are present in C horizons at depths of 23-41cm. Soil reaction of the A1 and B2 horizons in these soils ranged from pH 6.3 to 7.7, with electrical conductivities varying from 0.2 to 1.1 mmhos per cm.

Discussion

Artemisia arbuscula, *A. longiloba*, and *A. nova* vegetation is present in numerous states surrounding Nevada (Ward, 1953; Beetle, 1960). Studies in these areas have generally indicated that the distributions of these species are edaphically determined.

Eckert (1957), Tueller (1962), Culver (1964), Hall (1967), and Dealy (1971) found *A. arbuscula* associations in central and southeastern Oregon to occur on soils that were shallow, stony, and had moderately to strongly structured B2t horizons high in clay and very close to the soil surface. Hugie, Passey, and Williams (1964) and Tisdale, Hironaka, and Fosberg (1965) in southern Idaho and Robertson, Nielsen, and Bare (1966) in Colorado report similar morphology for soils underlying *A. longiloba* communities. Fosberg and Hironaka (1964) compared soils supporting *A. arbuscula* and *A. tridentata* communities in southern Idaho. *A. arbuscula* was restricted to soils that had a clay B horizon or bedrock within 33 cm from the surface or to weakly developed soils that were as deep as 50 cm but had over 30 percent gravels and cobbles distributed throughout their profiles. Soils supporting *A. tridentata* communities were deeper and had weaker profile development. They suggested that the properties of the *A. arbuscula* soils result in conditions of poor aeration in the rooting zone during the winter and spring months due to the development of a perched water table above the dense clay horizon or bedrock. Summerfield (1969) concluded that the depth of a clayey horizon of prominent, compound prismatic, and blocky structure below the soil surface was the only consistent morphological difference between soils supporting *A. arbuscula* and *A. tridentata* communities in northwestern Nevada. These horizons occurred from 7 to 31 cm under *A. arbuscula* communities and 31 to 53 cm under *A. tridentata* communities.

Shantz (1925), Shreve (1942), Fautin (1946), Thatcher (1959), and Richards and Beatley (1965) describe *A. nova* communities occurring on gravelly, shallow soils on ridgetops or slopes. Andre, Mooney, and Wright (1965) observed that in the White Mountains of California *A. nova* was most prevalent on limestone areas. Hironaka (1963) found that *A. nova* occurred on highly calcareous soils and shallow gravelly soils developed from limestone parent material.

Although there is considerable variation in the soils of the habitat types described in this study, four salient features appear consistently among the soils. These features are: (1) shallowness and thinness of the sola, (2) presence of a dense clay B horizon close to the soil surface, (3) a high volume of gravel throughout the profile, and (4) presence of mineral carbonates throughout most sola of the *A. nova* habitat types. The regularity of occurrence of these features is confirmed by the studies of Blackburn et al. (1968, 1969) of the vegetation and associated site characteristics on watersheds throughout northern Nevada. The presence of a dense clay B horizon was the most commonly occurring feature among the *A. arbuscula* and *A. longiloba* soils. In soils lacking this prominent horizon, very high gravel volumes occurred throughout the profile. Not all of the soils that lacked this dense clay B horizon were shallow, however . Several of the soils contained no restricting layer within a meter of the soil surface, indicating that extreme droughtiness may be the dominant physical factor of these soils. Shallowness, high gravel volumes, and presence of large quantities of mineral carbonates were the most commonly occurring features of the *A. nova* soils.

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